

EXPERIMENTAL STUDY ON IGNITIONS OF THATCHED ROOFING ASSEMBLIES EXPOSED FROM FIREBRANDS

Sayaka Suzuki¹ and Samuel L. Manzello²

¹National Research Institute of Fire and Disaster, Japan

²National Institute of Standards and Technology, USA

1. INTRODUCTION

It is well known that structures with thatched roofing assemblies are prone to ignition [1]. Counter measures to prevent structures with thatched roofing assemblies igniting have been studied and external sprinklers were implemented, especially for historical buildings, such as UNESCO world heritage sites in Japan [1]. It is believed that firebrands penetrate the thatched roofing assembly and smolder, which eventually leads to ignition and damage to buildings [1]. Yet, fundamental ignition studies of thatched roofing assemblies by firebrands were never carried out. Past experiments with thatched roofing assemblies were performed with a burning wood crib placed on the roof top or using a gas burner, rather than simulating the actual phenomena of firebrand showers attacking the thatched roofing [2, 3].

In this study, the reduced-scale continuous-feed firebrand generator (the continuous-feed baby dragon) was used to simulate firebrand showers attacking a mockup thatched roofing assembly under a 6 m/s wind in NRIFD's wind facility.

2. EXPERIMENTS

Experiments were performed by using the continuous-feed baby Dragon, shown in **Fig. 1**. Details of the experimental facility and experiments using other mockup roofing assembly types are elsewhere [4]. The reduced-scale continuous-feed firebrand generator consisted of two parts; the main body and continuous feeding component. The capability of a smaller-sized firebrand generator to develop continuous firebrand showers has been described [4].

For all experiments here, Japanese Cypress wood chips were used to produce firebrands. These were provided from a supplier and upon arrival, these chips were filtered using a 1 cm mesh to remove very fine wood pieces. The chips were also oven dried. These size wood pieces were selected to produce firebrands with larger projected area at a specific mass than that used in our prior studies using continuous firebrand generation focused on vegetative firebrands. The wood feed rate used here was 80 g/min, which is near the upper limit for this reduced-scale firebrand generator [4].

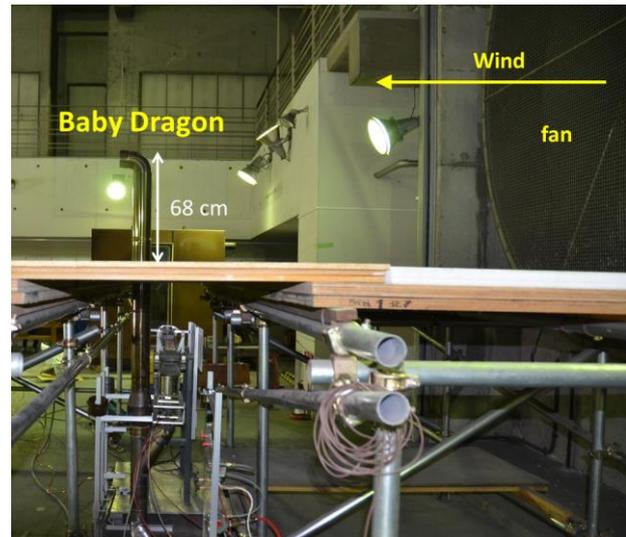


Figure 1 Experimental Settings.

As the base of the fan used to generate the wind in the NRIFD facility is located 1.6 m from the floor, the conveyer was placed under a custom stage designed for experiments when using NRIFD's wind facility. The wind field exits from a 4.0 m diameter fan, and it is possible to generate wind speeds up to 10 m/s. The flow field was measured to be within $\pm 10\%$ over a cross-section of 2.0 m by 2.0 m.

When the blower was set to provide an average velocity below 4.0 m/s measured at the exit of the firebrand generator with no wood pieces loaded, insufficient air was supplied for combustion and this resulted in smoke being generated in addition to firebrands. Above 4.0 m/s, smoke production was mitigated but then many firebrands produced were in a state of flaming combustion as opposed to glowing combustion. In these experiments, glowing firebrands were desired [4].

A mock-up thatched roofing assembly was constructed for this experimental series and the size of the mock-up was 0.9 m (W) x 1.1 m (H) x 0.4 m (maximum thickness) with an angle of 45 degrees. The thatched roofing assembly was made from water reed (main materials), bamboo and wood frame, shown in **Fig. 2**. The thatched roofing assembly was placed at 0.5 m downwind from the

baby Dragon. This location was picked for the roof to receive adequate amount of firebrand showers.



Figure 2 Thatched roofing assembly used for the experiment.

3. RESULTS & DISUSSIONS

Not all firebrands from the Dragon arrive at the roof and the number of firebrands arriving on thatched roof was measured to be 7.3 /sec. Most of firebrands landing on the roof landed on the lower half of roof, but again not all firebrands landing on roof stayed on the roof. Some were blown away, some penetrated between the water reeds, and some stayed on the surface for a while. Images of an experiment were shown in **Fig. 3**. No smoke was observed until ignition and once ignited, fire was rapidly spread within the thatched roofing assembly.

4. SUMMARY

Experiments with thatched roofing assemblies were performed by using the continuous-feed reduced-scale firebrand generator in NRIFD's wind facility to investigate fundamental ignition mechanism. The wind speed of 6 m/s was selected to observe the ignition and flame spread of thatched roofing assembly. It is revealed that firebrands penetrated into the thatched roofing assembly, sometimes unseen from the outside, resulting in ignition and ultimately rapid flame spread. Basic information obtained in this study would be useful to compare with the results using burning wood cribs done in past research and subsequently to evaluate and develop effective counter measures to protect historical structures with thatched roofing assemblies.

5. REFERENCES

[1] FDMA, Final Report on methods to protect Cultural Property from fire, 2011.03. <http://www.fdma.go.jp/html/data/tuchi2304/pdf/230422-index.pdf> (in Japanese) [2] Murata, S. et al, Proceedings of annual JAFSE conference, 250-251, 2016. (in Japanese) [3] Murata, S. et al,

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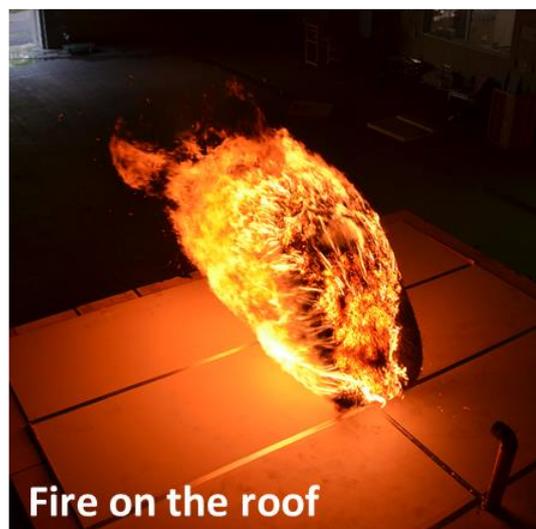
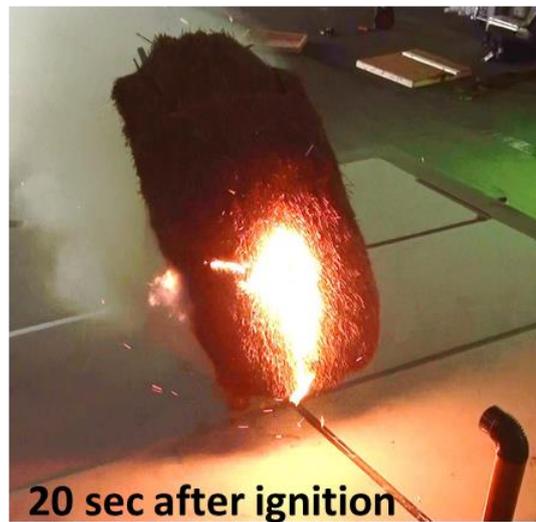
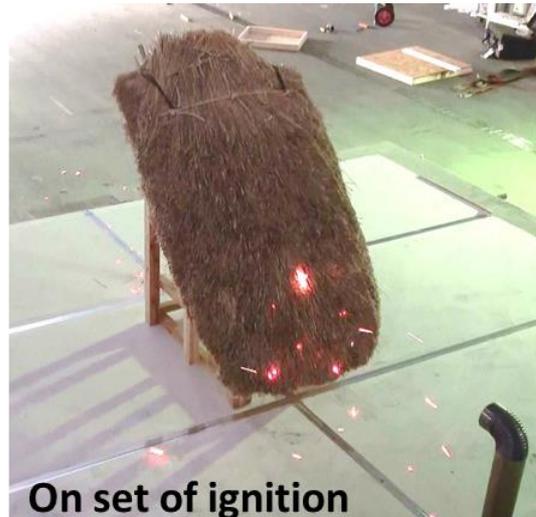


Figure 3 Images of thatched roofing assembly during an experiment under a 6 m/s wind.